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ABSTRACT

To identify the early precursors of interest or disinterest in mathematics, this study focused on the mathematical attitudes, aptitude, and achievement of males and females in grades 3-6. Some general personality factors which might affect participation were also examined. The results indicate that sex differences in attitudes are evident as early as third grade and that both sexes of elementary school children consider mathematics a male subject. Other conclusions are: (1) attitudes seem to affect students' mathematics achievement scores in elementary school; and (2) a large degree of stereotyping is associated with mathematics and this stereotyping begins very early during development. (MP)

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# Nice Girls Don't Study Mathematics: The Perspective from Elementary School

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SESSION # 1.10

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Today I will be discussing the role of women in mathematics with a particular emphasis on sex roles and sex role stereotyping. According to H. J. Eysenck (1953), the term stereotype was first applied to the field of attitudes by the well known newspaper columnist, Walter Lippmann. Eysenck quotes Lippmann (p. 244) as saying "For the most part we do not see and then define, we define first and then see . . . we pick out what our culture has already defined for us and we tend to perceive that which we have picked out in the form stereotyped for us by our culture." Lippmann's notions of stereotyping are consistent with constructive theory developed by Piaget and others.

The basic rationale underlying the present research program is that differences between males and females in their attitudes toward mathematics may contribute to differential achievement and participation in mathematics. Our research strategy was the following: First, document the existence of stereotypes associated with mathematics. Second, determine the extent to which children in various age groups hold different attitudes, particularly stereotypic attitudes, about mathematics. Third, investigate the sources of these stereotypes, and, finally, determine the effects of these stereotypes on mathematics achievement.

Ph.D. Study

We began the study by sending out questionnaires to women throughout the country who had obtained Ph.D.s in mathematics, English and psychology. After mailing out about 1000 questionnaires, we received a total of 460 completed questionnaires: 279 from mathematicians, 90 from English Ph.D.s and 91 from psychologists. Response rates were approximately equal for the three groups.

One of our primary goals was to determine the degree to which these women believed that society stereotypically characterized women in their

fields. The mathematicians reported the highest level of stereotyping, and there was stereotyping associated with women in all three fields: 83% of the mathematicians responded that women are stereotyped in their field, whereas 74% of the English Ph.D.s and 65% of the psychologists indicated society stereotypes women in their field. Differences in these response patterns were highly significant ($p < .01$) as tested by Chi square (Table 1).

We also asked the Ph.D.s if society characterized their fields as masculine, feminine or neutral. The majority of the mathematicians indicated that society considers their field to be "decidedly masculine", whereas the English Ph.D.s indicated that society considers their field "somewhat feminine". Most of the psychologists indicated that society considers their field neither masculine nor feminine. Again a Chi square test indicated that differences among the groups were highly significant ($p < .01$). Note that mathematics was the field considered by the women to be most masculine and was also the field associated with the highest degree of stereotyping.

We asked the respondents to list the <u>specific</u> stereotypes associated with women in their fields. A list of the ten most frequently named stereotypes for each field is shown in Table 2. Notice that the stereotypes "masculine" and "unfeminine" are ranked higher for the mathematicians. The stereotype "masculine" is ranked fifth for the psychologists and does not appear in the top ten list for the English Ph.D.s. The word "unfeminine" does not appear in either the psychologists' or English Ph.D.s' top ten list. When we looked at the sex roles of these women using Bem's Sex Role Inventory (1974), it was apparent that women in mathematics are not unfeminine nor are they any more masculine than women in English. On another item, the respondents themselves indicated that the stereotypes that they had listed were generally <u>inaccurate</u> characterizations of women in their fields.

TABLE 1

Percentage of Female Ph.D.s indicating that society Stereotypes Women in Their Fields ($p < .01$)*

| | YES (%) | NO (%) |
|---|---|---|
| Mathematics (n = 274) | 82.8 | 17.2 |
| English (n = 88) | 73.9 | 26.1 |
| Psychology (n = 91) | 64.8 | 35.2 |

*Five mathematicians and two English Ph.D.s did not response to this item.

TABLE 2

Stereotypes Perceived by Female Ph.D.s in Three Areas

| | Mathematicians | English Ph.D.s | Psychologists |
|---|---|---|---|
| 1. | Unattractive | Overly-Intellectual | Aggressive |
| 2. | Masculine | Unattractive | Not as competent as men |
| 3. | Cold/Distant | Old Maid | Interested in children |
| 4. | Unfeminine | Out of touch with reality | Interested in helping people |
| 5. | Intelligent | Aggressive | Masculine |
| 6. | Overly-Intellectual | Obsessed with proper grammar | Analytical |
| 7. | Incompetent compared with males | Not serious | Cold/Distant |
| 8. | Aggressive | Picky | Intelligent |
| 9. | Socially awkward | Non-domestic | Many personal problems |
| 10. | Analytical | Non-sexual | Can read your mind |

The women were asked to indicate the source of stereotypic information. That is, who in their environment first provided knowledge about the content of stereotypes about women in their professions (see Table 3). The results were similar for the three groups: The respondents felt that their peer groups were the primary source of stereotypes, particularly the male peer group. Notice that peer groups were named much more frequently than either family members or the media. Importantly, the respondents indicated that they generally learned these stereotypes in junior or senior high school.

TABLE 3

Source(s) of Stereotypic Information*

| Source | Math % | Source | Math % |
|---|---|---|---|
| (1) Male Peer | 43.0 | (7) Radio | 10.0 |
| (2) Female Peer | 39.8 | (8) Mother | 9.3 |
| (3) Printed Matter | 29.7 | (9) Female Teacher | 8.2 |
| (4) Movies | 25.1 | (10) Father** | 5.0 |
| (5) Television | 25.1 | (11) Male Sibling | 2.9 |
| (6) Male Teacher | 15.8 | (12) Female Sibling | 1.1 |

* Data was obtained from the women who indicated stereotyping in their fields.

** Indicates significant difference among three groups ($p < .01$).

At this point, I want to make the point that there are two kinds of stereotyping associated with mathematics. First, mathematics is considered a masculine subject, that is, an area that belongs in the male domain. Second, as we have seen, there is a great deal of stereotyping associated with women who venture into this domain.

Elementary School Study

We wondered if stereotypes were deterring women from participating in mathematics and at what age children began labeling mathematics as a subject belonging in the male domain. In an attempt to determine early precursors of sex differences in mathematics, we decided to focus on children in elementary school. The purpose of this study was to investigate sex differences in math attitudes, including stereotypic attitudes, and to determine the extent to which these variables might affect their mathematics achievement scores. We administered a questionnaire to 562 children in grades 3-6 in the Boulder Valley School District. The questionnaire contained an instrument assessing spatial ability, items assessing children's beliefs and attitudes about mathematics, and several other personality measures. Achievement scores and aptitude scores were taken from the McGraw Hill Test of Basic Skills. This test is administered to students in Boulder Valley each year as part of their annual testing program.

The total mathematics achievement score is comprised of scores from three subtests: computation, concepts and applications. We did not obtain sex differences on total scores in mathematics. The attitudinal items yielded complex results, and I will only touch on a few of the more important ones today.

Math in Male Domain

Do elementary school children consider math to be in the male domain? Do they consider males as being more capable and as being more involved in mathematics? Our data indicates that there is a large difference between the children's stereotyping of math in the adult world and their stereotyping of math among their peers. When we asked the children about math ability among their peers, in general, girls responded that girls were better in math and boys responded that boys were better in math. With age, however, the girls begin to shift toward favoring the boys. As a comparison, we also asked who was better in reading, boys or girls? The change with age in the girls' perceptions of reading ability is not nearly has dramatic as the change that occurs in mathematics.

We see a different pattern of results in our questions about adults. We asked two questions about adult ability in math and one question about usage of a hand calculator. Clearly the children consider adult males to be more involved with math, as demonstrated by greater usage of a hand calculator, and as being far more capable than adult women in mathematics. On these items, both boys and girls, and not just the boys, consider math to be in the male domain.

On responses to an item asking whether men or women are better at filling out an income tax form, children of both sexes indicated that adult males are more competent than adult females. On an item which asked who could work with numbers better, children of both sexes agreed that adult males were more competent, and the boys were stronger in this belief ($p < .01$). There were no significant changes with grade in these perceptions.

Thus, as early as the third grade, children perceive males as more capable and more involved in mathematics, but there are differences depending on the age of the referrent group to which the item is addressed.

## Math Attitudes

As a first step in constructing our math attitude scales, we factor analyzed the majority of our attitude items. Five items related to personal attitudes toward math combined to form the first factor. These items included liking of math, interest in math, enjoyment of math, difficulty of math and whether math was their best subject. We scaled these items and called the resulting scale our math attitudes-self scale. The results of an analysis of variance indicated that both boys and girls appear to be at the same level of liking math in grades 3 and 4. The boys continue liking math to this same degree in grades 5 and 6. The girls, however, decline somewhat during grades 5 and 6 ($p < .03$).

A second set of items related to peer attitudes toward math formed factor II. There was a suggestion based on an analysis of variance that the girls perceive a decline in their friends' liking math with grade ($p < .09$).

## Math Liking

In order to more closely examine the attitudinal data, I want to focus on several individual items dealing with math liking. These questions were all presented in a four choice Likert format and were as follows:

How much do you like mathematics?

How much does your mother like mathematics?

How much does your father like mathematics?

How much does your teacher like mathematics?

How much do your friends like mathematics?

We obtained an interesting pattern of results with these items. On the two items dealing with mother and father liking of mathematics (see Figure 1), we found a sharp decline in the older girls' perceptions of their mothers' liking of mathematics. Both the older and younger girls perceive that their

fathers like math more than their mothers, and age did not affect the girls' perceptions of their fathers' liking of math. The older and younger boys also see their fathers and mothers liking math at more constant levels than the older and younger girls.

We also found that the children attributed the highest degree of math liking to their teachers (see Figure 2). Both boys and girls see their friends as liking math less than they themselves like math. One explanation is that children are more likely to give what they perceive to be socially desirable responses when indicating how much they like math than when they are reporting their friends' liking of math. A second explanation is that among elementary school children, expressed negativity about math is the "acceptable" way of behaving and expressing a positive attitude is unacceptable. Thus, many of the children may hold more positive attitudes than they lead their peers to believe. A correlation between self-liking of math and friends' liking of math was highly significant.

Attitudes and Math Achievement

When predicting math achievement scores using a heirarchical regression model, non-language aptitude was the strongest predictor for both boys and girls. Spatial ability also was a strong predictor of math achievement for both boys and girls. We were able to predict math scores on the basis of some of our personality variables to a small, but significant degree. The self attitude math scale entered into the regression equation more strongly for the boys than for the girls.

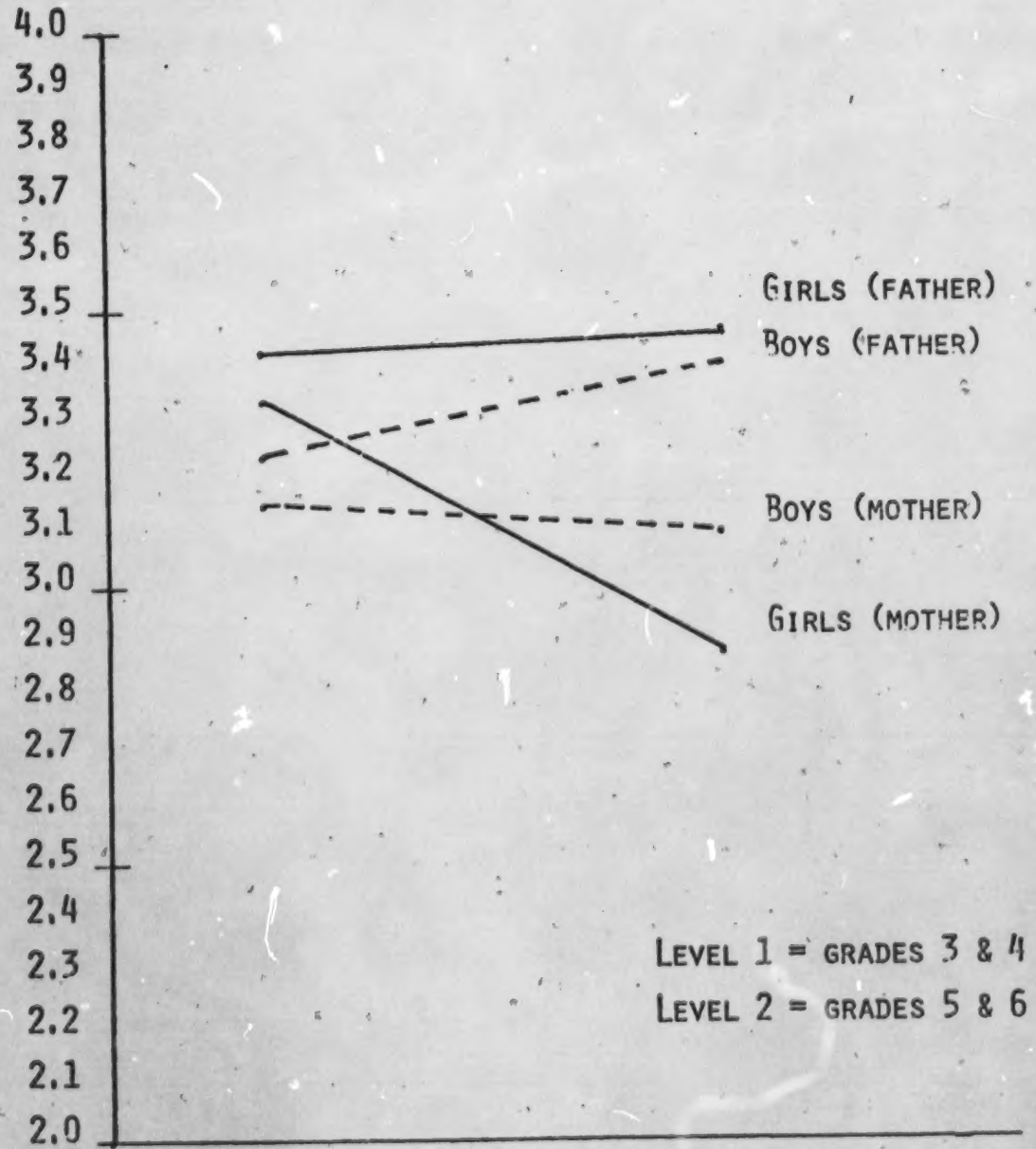
We also entered the items dealing with liking into regression equations. Admittedly, these results are tentative since we are dealing with single items and not scales. The results were interesting. For the girls, both teachers' liking of math and fathers' liking of math entered into the

## FIGURE 1

### PARENT LIKING OF MATH

HOW MUCH DOES YOUR FATHER LIKE MATH?
HOW MUCH DOES YOUR MOTHER LIKE MATH?
(SEX X GRADE $p < .01$)

1 = NOT AT ALL
2 = NOT VERY MUCH
3 = SORT OF
4 = ALOT



HOW MUCH DOES YOUR MATH TEACHER LIKE MATH?

HOW MUCH DO YOU LIKE MATH?

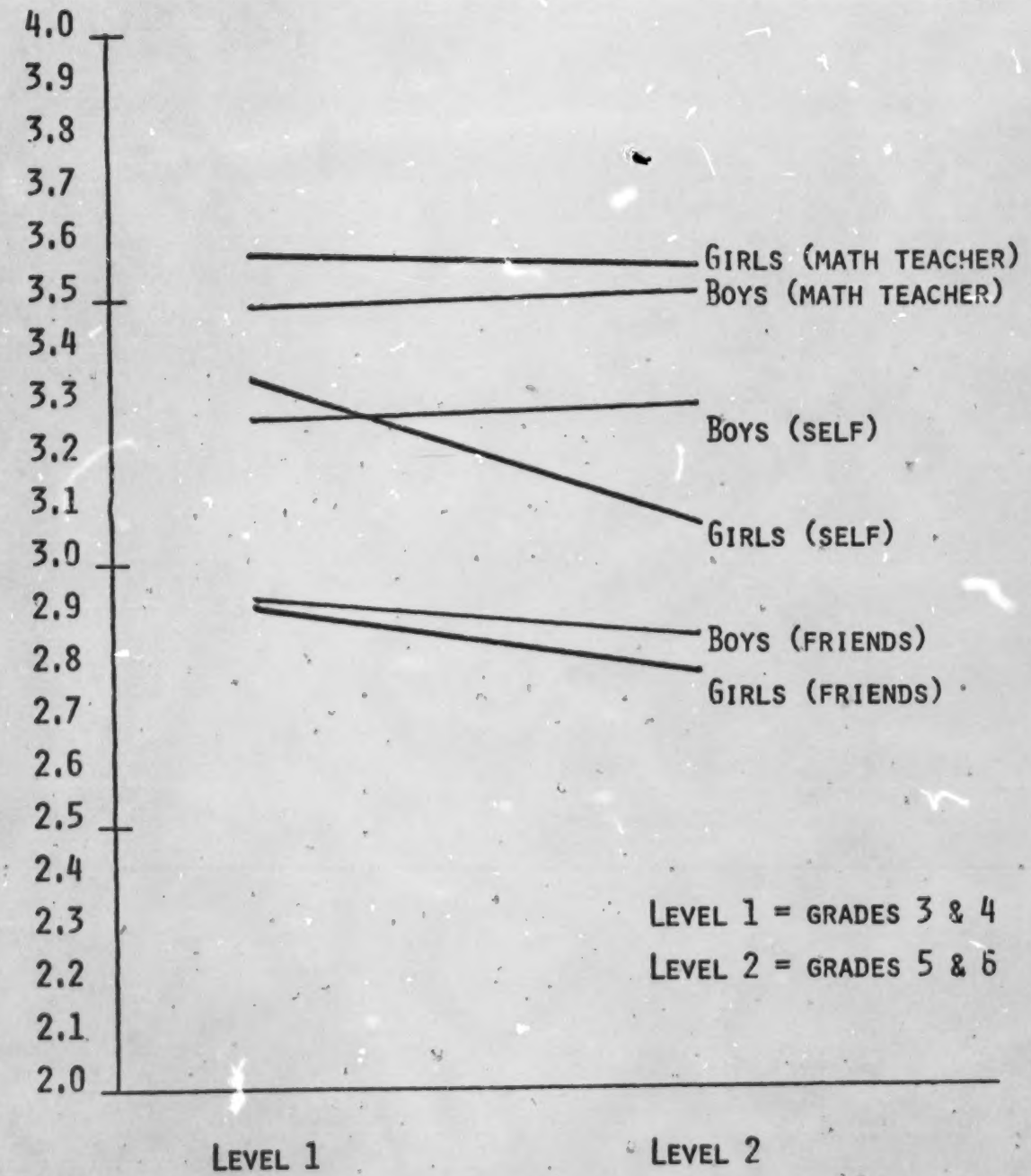
HOW MUCH DO YOUR FRIENDS LIKE MATH?

4 = ALOT

3 = SORT OF

2 = NOT VERY MUCH

1 = NOT AT ALL



regression equation to a significant degree. For the boys, only fathers' liking of math entered into the equation. Neither boys nor girls seemed influenced by their mothers' liking of mathematics.

On the basis of this study, we may conclude that:

1) Attitudes seem to affect students' mathematics achievement scores in elementary school.

2) As early as elementary school, sex differences emerge in children's attitudes toward mathematics, although there were no over-all sex differences in math achievement scores.

3) Children perceive math to be in the male domain in the adult world.

4) Girls in grades 5 and 6 perceive their mothers and their friends as liking math less than girls in grades 3 and 4 perceive their mothers and friends as liking math.

It is clear from these studies that there is a large degree of stereotyping associated with mathematics and that this stereotyping begins very early during development.

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